CERN COURIER NEWS

Los Alamos s new superconducting spoke cavities have shown excellent results

Superconducting (SC) RF cavities have been used for accelerators for high-energy and nuclear physics in the past few decades. The technologies to get high fields and high quality factors for elliptical cavities for electron acceleration, e.g., the ones for TESLA project, have come close to maturity. In recent years, with the difficulty of adopting conventional elliptical cavities due to mechanical weakness, the demand to develop different types of SC cavities for lower velocity particles has emerged to reduce the costs of future accelerators such as spallation neutron sources, rare isotope accelerators, and accelerator-driven waste transmutation systems.

One of the promising candidates is the spoke cavity. This is an invention of Jean Delayen and Ken Shepard at the Argonne National Laboratory (ANL) in the late 1980s to make it easier to extend the acceleration length of half-wave coaxial resonators by adding more spokes in one cavity.

At LANL, the development of spoke cavities started in 2001under the Advanced Accelerator Applications (AAA) program for the technology development of accelerator-driven waste transmutation system. We have designed a β (fraction of light velocity) = 0.175, 350 MHz, 2-gap spoke cavity and procured two cavities from industry (Zanon, SpA).

Figure 1 shows the cavity. The diameter of the cavity is 40 cm, the beam aperture is 5 cm and the accelerating length is 10 cm. One of the benefits of the spoke cavity is its size being about half for the same frequency, as compared to the elliptical one. Conversely, a spoke cavity would operate at one-half the frequency of a similar size elliptical cavity, increasing the active length by a factor of two and enabling the operating temperature at 4.5 K with resulting savings in the installation and operating cost of the cryoplant.

Figure 2 shows the quality factor as a function of accelerating gradients of one of the two cavities, together with the AAA design goal. The two cavities reached 12.9 MV/m and 13.5 MV/m respectively at 4 K, exceeding the present AAA design goal of 7.5 MV/m by 72 — 80 %, which helps achieve very high reliability required for the waste transmutation application.

An international workshop on the advanced design of spoke cavities was held at Los Alamos on October 7 — 8, 2002 (http://laacg1.lanl.gov/spokewk/). Although there are still issues to be discussed such as drive couplers, multipacting and higher-order modes, this excellent result has encouraged us to strive for further development of multi-spoke cavities. The spoke cavity might also be a cheaper and better option for medium velocity (β~0.6) particles. See more detail on our activities at http://laacg1.lanl.gov/scrflab/.

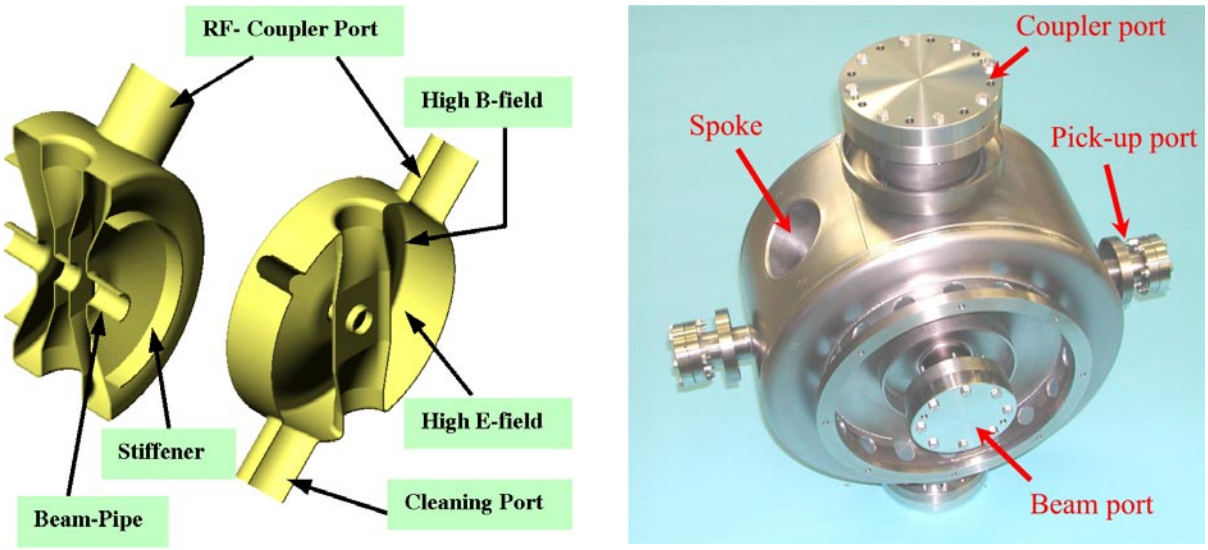

Figure 1: The LANL/AAA spoke cavity. The cut-away images (left) and the fabricated cavity (right).

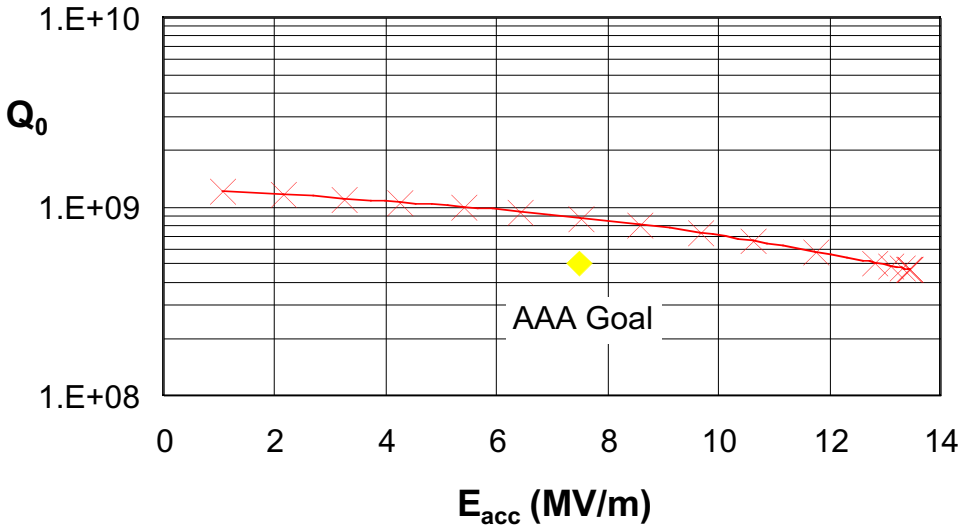

Figure 2: Quality factor as a function of accelerating gradient at 4 K of one of LANL/AAA spoke cavities.